BOONTON ELECTRONICS CORPORATION

N. S. 0969-097-5010

Technical Manual for Model 91CA RF Voltmeter

300 μV - 3 V
10 Kc - 600 Mc

Model 91CA

Approved: 25 October 1966

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SECTION I

SPECIFICATIONS: RF VOLTMETER MODEL 91CA

Measurement Range:		300 microvolts to 3 volts
Full Scale Ranges:		.001, .003, .01, .03, .1, .3, 1, 3 volts
Frequency Range:		10 Kc to 600 Mc
Accuracy:	.003 range and above	5% F.S. 50 Kc to 400 Mc 10% F.S. 10 Kc to 50 Kc & 400 Mc to 600 Mc
	.001 range only	10% F.S. 50 Kc to 400 Mc 15% F.S. 10 Kc to 50 Kc & 400 Mc to 600 Mc
Input Impedance:		91-3D RF Probe See curve for input resistance data on high impedance probe. Shunt capacitance varies inversely with input voltage from 1.5 to 3pF approx.
		91-8C 50Ω BNC Adapter Max. VSWR 1.2, 10 Kc to 600 Mc
		91-13B Probe Tip For direct measurements up to 250 Mc
Tube Complement:		1 each: BEC 525001, 7199, 6AU6, OA2, and 6X4
Power Requirements:		105-125 volts, 58-62 cycles, 30 watts
Dimensions:		7-5/16 W x 11-1/2 H x 11 D Overall
Weight:		12 pounds

SECTION II

GENERAL DESCRIPTION

The 91CA RF Voltmeter is a sensitive instrument for the measurement of voltages of 300 microvolts to 3 Volts spanning a frequency range of 10 kilocycles to 600 megacycles. In addition to conveniently measuring voltage levels in a diversity of RF circuits, the instrument has application for many associated tests. Such measurements include: the frequency response of both active and passive networks, i.e., amplifiers and filters; VSWR and return loss on transmission lines and attendant systems; attenuation and insertion loss of RF attenuators; and high frequency parameters of transistors. With true RMS response below 0.03 Volt, wide band noise can be measured, and using suitable null networks measurement of the harmonic distortion of RF waveforms can be performed without the attendant errors of average type meters.

The instrument is also useful as an RF null detector for bridge measurements and analogous techniques when a sensitivity in the order of 200 microvolts will suffice.

Supplied with each instrument is a general purpose RF Probe, 50 Ohm Adapter, and Probe Tip. The adapter is fitted with a BNC coaxial connector and provides a 50 ohm termination with a low VSWR up to 600 megacycles. The Probe Tip is useful for direct measurement to approximately 250 megacycles, however, a short wire should be substituted for the ground lead when using above 100 Mc to minimize the effects of ground lead inductance. Above 250 megacycles, the probe may be used directly without the tip but the connecting leads must be extremely short to avoid resonant effects. Normally, the RF Probe is used with the 50Ω Adapter in a coaxial system for accurate measurements above 100 Mc.

The RF Probe with its full-wave crystal detecting circuit produces a true RMS response without turnover, or harmonic errors for all voltage levels below 0.03 Volt, gradually changing to peak-to-peak reading (calibrated in RMS) at approximately 1.0 Volt. The probe has a shunt capacitance of approximately 2.5 pF at levels of 0.3 Volt or higher, increasing slightly at levels of 0.1 Volt or less. (see Fig. 2) The shunt resistance component shown in Figure 1 is a variable factor, depending on the voltage and frequency.

A db scale in red on the panel meter and range switch provides a convenient means of expressing relative voltage measurements.

There is no zero control but instead a balancing control allows residual indications due to noise to be minimized resulting in excellent stability and ease of reading even on the most sensitive range.

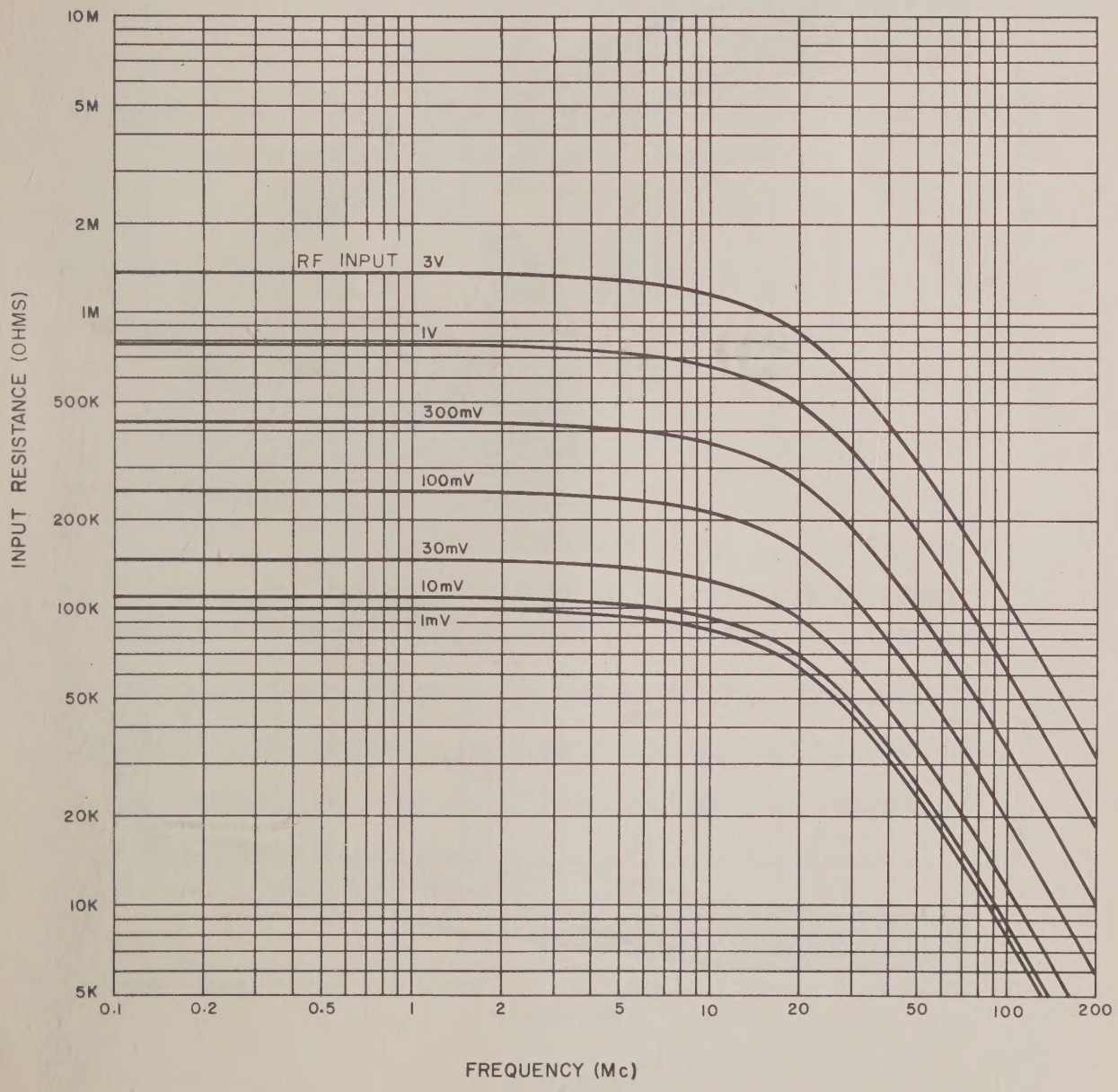

Figure 1

INPUT RESISTANCE OF RF PROBE

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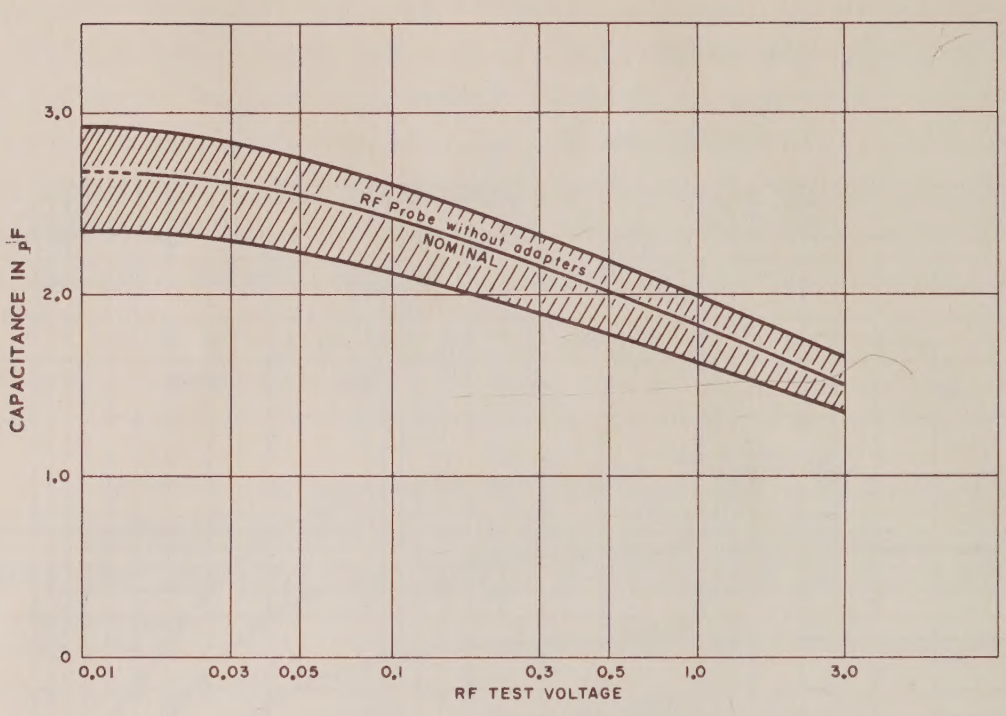

Figure 2

INPUT CAPACITANCE OF RF PROBE (MEASURED AT 10 Mc)

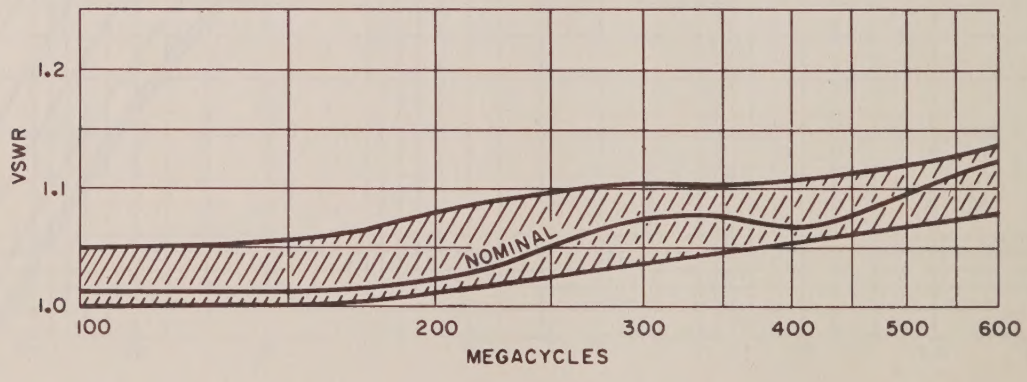

Figure 3

VSWR OF RF PROBE WITH 50 OHM ADAPTER ATTACHED

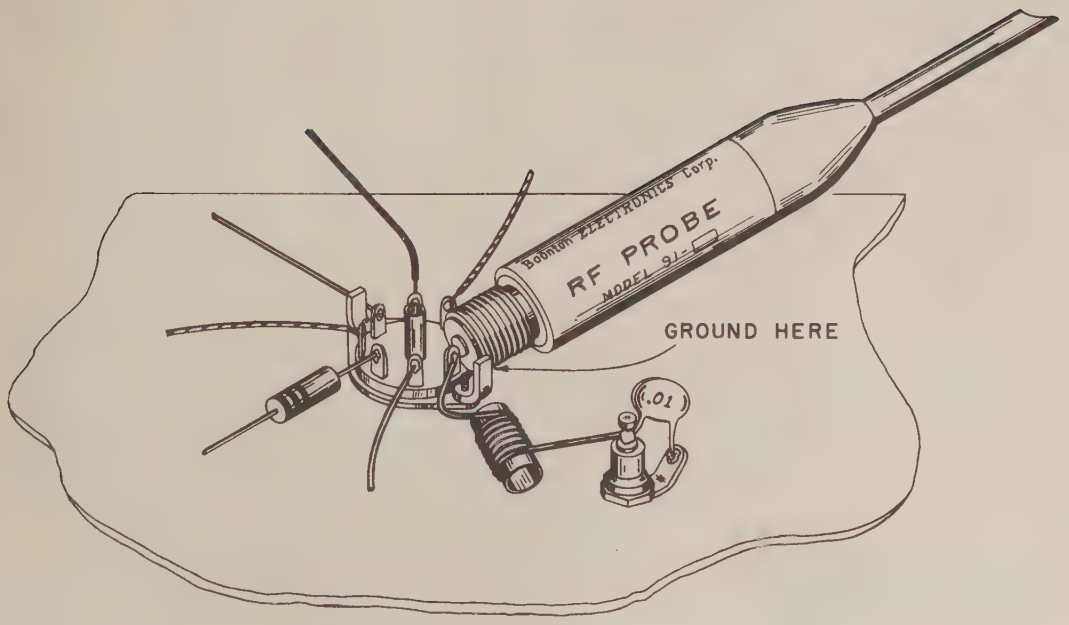

Figure 4

METHOD FOR MAKING LOW INDUCTANCE CONNECTIONS DIRECTLY TO TEST SIGNAL POINT USING THE RF PROBE. USE FOR IN-CIRCUIT MEASUREMENTS WHEN LOWEST CAPACITANCE LOADING IS REQUIRED OR WHEN INDUCTANCE OF PROBE TIP GROUND LEAD CANNOT BE TOLERATED.

SECTION III

OPERATING PROCEDURE

3.1 General Information

This section should be read carefully before using the instrument. It contains information necessary for proper operation of the RF Voltmeter.

The power line frequency and voltage requirements of the instrument are 105 to 125 Volts, 58 to 62 cycles. It is important that it is plugged into its proper power source.

3.2 Turn-on Procedure

a. With the power cord plugged into an appropriate AC source, turn the instrument on and allow a warm-up period of approximately one minute.

b. Connect the RF Probe cable to the "PROBE" receptacle on the front panel. (Note: Check to determine that the serial number of the probe matches that of the instrument. Each RF Voltmeter is calibrated for its individual probe. If probes should be interchanged without recalibrating the instrument, errors in measurement may result.)

c. Attach 50Ω Adapter to RF Probe in order to shield the input from any stray RF fields (3.4c) before proceding to adjust BALANCE control (3.2d).

d. Set RANGE-FULL SCALE control to .001 and carefully adjust BALANCE control for minimum meter deflection. Normal meter deflection for zero input signal is as follows:

RANGE	DEFLECTION
.001	less than 3/4 inch
.003, .01, .03, .1, .3,	less than 1/16 inch
1, 3	Suppressed

3.3 Measurement Procedure

a. Set RANGE-FULL SCALE control to appropriate setting (or higher) for voltage to be measured.

b. For "in-circuit" measurements, remove 50Ω Adapter and attach Probe Tip to RF Probe. The Probe Tip is useful for direct measurement to approximately 250 megacycles, however, a short wire should be substituted for the ground lead when using above 100 Mc to minimize the effects of ground lead inductance. Above 250 megacycles, the probe may be used directly without the tip but the connecting leads must be extremely short to avoid resonant effects, see Fig. 4.

c. Connect ground clip or wire to suitable ground and connect tip to point where voltage is to be measured. Alternatively measurement may be made using direct connection (Fig. 4.).

d. Read RF voltage on appropriate meter scale corresponding to setting of RANGE-FULL SCALE control.

e. To obtain readings in decibels, add the db (red scale) meter reading to the db (red) setting of the RANGE-FULL SCALE control. Although individual db readings have no significance as absolute measurements, the difference between two db readings is a useful way of expressing voltage ratio.

f. For terminated measurements in 50Ω systems, the 50Ω Adapter should be attached to the RF Probe. Always

use the adapter wherever possible for accurate measurements above 100 Mc.

3.4 Operating Precautions

a. Maximum Input Voltages:

RF voltages exceeding 10 Volts must not be applied to the probe or permanent damage to the crystal diodes may result. The 50Ω Adapter should not be subjected to continuous overloads exceeding 10 Volts to avoid excessive heating of terminating resistor.

Maximum DC voltage for RF Probe is 400 Volts.

Maximum DC voltage for 50Ω Adapter is 10 Volts.

Note: Do not apply maximum DC voltage simultaneously with maximum RF voltage when using 50Ω Adapter.

b. Temperature Effects:

The normal ambient temperature range for specified accuracy is 65° to 90° F. Appreciable inaccuracies can be expected while the probe is exposed to temperatures above or below this range. No permanent change in probe characteristics will result from the high or low temperature exposure.

Inaccuracies due to temperature effects may occur after soldering to the Probe Tip or from heat sources such as resistors or tubes.

When making low level measurements in the order of 2 millivolts or less, it is important to make sure that the probe has attained a uniform temperature throughout. A temperature difference between the inside and outside of the probe can generate a small thermal voltage that may add to or subtract from the DC voltage generated by the diodes.

c. Hum, Noise, and Spurious Pick-up:

When measuring low level RF voltages, precautions should always be taken to avoid the possibility of erroneous readings resulting from hum, noise, or stray RF pick-up. Although all low frequency hum and noise is attenuated at the input by 60 db, it is still possible for high level unwanted signals to get through and cause errors. The best test for this condition is to reduce the test signal to zero level and note whether the voltmeter continues to read some spurious signal level. In some cases it may be necessary to provide extra shielding around the probe connections to reduce stray field pick-up. Typical sources of spurious radiation are induction or dielectric heating units, diathermy machines, local radio transmitters, grip dip meters, and amplifiers with parasitic oscillations.

d. Magnetic Fields:

Operation of the voltmeter in strong 60 cycle magnetic fields such as those surrounding unshielded power transformers should be avoided; otherwise a standing reading that cannot be nulled by the balance control may result. The magnetic field induces small 60 cycle currents in the amplifier section of the instrument which, due to the extremely high gain at this frequency, appear as an indication on the panel meter.

SECTION IV

THEORY OF OPERATION

4.1 An understanding of the operating features of the RF Voltmeter may be obtained by a study of the block diagram (Fig. 5) in conjunction with the following description.

The radio frequency voltage to be measured is rectified in the RF Probe by means of a full wave germanium diode rectifier circuit. The resulting DC potential is then attenuated as required before conversion to 60 cycle AC by the chopper. This AC signal is then amplified in a narrow band feed-back stabilized amplifier prior to its re-conversion to DC for use in actuating the meter.

The germanium diodes used in the RF Probe have been carefully selected for several characteristics. As the selected diodes do not all exhibit the same rectification efficiency characteristics, it becomes necessary to adjust each meter range to match individual probe diodes. The range adjustments consist of individual non-linear circuits shunting the output meter circuitry. As the RANGE switch is set to the required test voltage position the appropriate non-linear adjusting circuit is automatically shunted across the output. It is also important to understand that the non-linear output circuitry is designed to compensate for the non-linear characteristics of the probe diodes when operating at levels below 0.3 Volt.

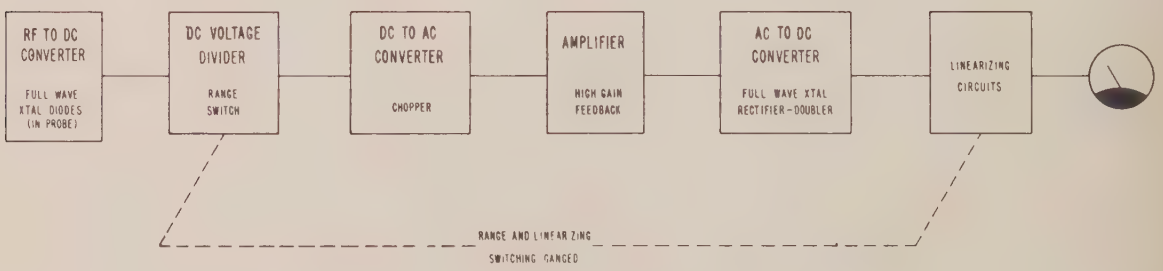

Figure 5

BLOCK DIAGRAM OF RF VOLTMETER

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SECTION V

MAINTENANCE

5.1 Periodic Checking

The RF Voltmeter is designed to give long periods of service without maintenance when operated in accordance with these instructions. It is recommended, however, that the instrument be checked occasionally using reliable standards to insure against errors resulting from deterioration of tubes or chopper. To make these checks, it is necessary to have a signal source in the 200 to 500 Kc region with less than 2% distortion at levels up to 3 Volts across 50Ω. A precision electronic voltmeter of the averaging response type, such as the Ballantine Model 310A or 314, Hewlett Packard Model 400D or 400H, may be used to monitor the signal source for this purpose. To insure its accuracy, the monitoring meter should be checked at some low frequency (50-100 cycles) of good waveform against a dynamometer type AC meter of at least 1% accuracy.

5.2 Calibration Precautions

When attempting to check the voltage calibration accuracy on an instrument having the sensitivity and bandwidth of this RF Voltmeter, it is essential to take precautions to avoid errors resulting from stray pick-up voltages. (See paragraph 3.4c,d). A well shielded signal source must be used in conjunction with coaxial connections to both the RF Voltmeter and the standard referenced meter. Even with a well shielded generator and associated connections, it is sometimes possible for the reference meter to pick up stray RF signals and feed them into the probe. Check for this condition by disconnecting the standard meter and noting change in level.

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5.3 Calibration Check Procedure

With suitable calibrating equipment (paragraph 5.1) and taking necessary precautions (paragraph 5.2), we can now check calibration accuracy. Each range should be checked at a voltage representing 90% of full scale value. If these check points agree within ± 2% of the standard, it is recommended that no adjustment be made. If the check points deviate by more than ± 5% from the standard, it is recommended that a trouble shooting procedure be followed as outlined in paragraph 5.4. If the check points fall between 2% and 5% of the standard, the calibration adjustment procedure as outlined in paragraph 5.5 should be followed.

5.4 Trouble Shooting Procedure

a. Case Removal

The instrument may be removed from its case after first removing the two screws located at the back of the case (near the bottom) and the four screws located on the sides of the case near the front.

The power supply may be removed from the case after first removing the four screws located on the sides of the case near the rear.

b. Tube Replacement

If the tube V1 should become weak or noisy, it should be replaced with Boonton Electronics Part Number 52500l. A commercial low noise 12AX7 which has low microphonism and meets the requirements of paragraph 3.2c may be used if a BEC 52500l is not available. The Telefunken ECC83/ 12AX7 has been found to meet these requirements consistently. After replacing this or other defective tubes, re-check calibration as outlined in paragraph 5.3 and adjust if necessary as described in paragraph 5.5

c. Chopper Replacement

If satisfactory operation is not obtained by replacing

tubes, a replacement chopper should be tried. If the new chopper does not clear the difficulty, place the original chopper back in socket. The calibration accuracy must be re-checked. If the chopper is replaced, the drive coil connections should be reversed (twisted pair from chopper top cap to meter terminal board) to discover which polarity gives lowest residual meter deflection (para. 3.2c) The leads should then be resoldered in this polarity.

d. Voltage and Resistance Tests

After determining that the trouble cannot be cured by replacement of tubes or chopper it is advisable to make a systematic check of AC voltage, DC voltage, and resistance at each socket pin. Table I shows the nominal AC and DC voltages to ground from each socket pin number. Table 2 shows the nominal resistance values expected for each point. Large or erratic deviations from the listed values of voltage or resistance will serve as a clue in tracking down a faulty component. Once the trouble has been found and corrected, the calibration must be re-checked and re-adjusted as outlined in paragraph 5.3 and paragraph 5.5

e. RF Probe Replacement:

Probes that have been damaged by overload or have become inoperative or insensitive for any other reason should be replaced rather than repaired. After replacement calibration must be rechecked and adjusted if necessary. The Probe serial number should agree with that of the instrument; if exchanged, recalibration may be necessary.

5.5 Calibration Adjustment Procedure

Before making any calibration adjustments, it is essential to provide the necessary reference standards as described in paragraph 5.1 and take all precautions as outlined in paragraph 5.2. The calibration adjustment procedure shall then be made as outlined in Table 3.

TABLE 1

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TEST POINT VOLTAGES

Conditions:

117V 60 cycle line input.
Readings are in volts unless otherwise shown.
All measurements to chassis unless otherwise noted.
Input 0.0IV at any frequency between 100 Kc and 1 Mc.
Use Ballantine Model 314 VTVM for all AC voltage measurements.
Use Hewlett-Packard Model 410B or C for all DC voltage measurements.

Pin #		1	2	3	4	5	6	7	8	9	10	11
Tube V1 BEC 525001	DC	70	0	0.76	53	53	90	0	0.85	47	-	-
	AC	2.7mV	1.4mV	-	-	-	0.1	2.3mV	-	-	-	-
V2 (6AU6)	DC	0.69	1.7	.59	53	20	38	1.7	-	-	-	-
	AC	0.1	-	-	-	0.5	-	-	-	-	-	-
V3 (7199)	DC	300	100	50	0	0	1.35	-	170	150	-	-
	AC	0.4	21	-	0	6.3	-	0.1	18	21	-	-
V4 (6X4)	DC	-	-	-	-	-	-	400	-	-	-	-
	AC	340	-	6.3	0	-	340	-	-	-	-	-
V5 (OA2)	DC	150	-	-	-	150	-	-	-	-	-	-
	AC	-	-	-	-	-	-	-	-	-	-	-
J2 Socket	DC	-	-	-	-	52	-	150	300	0	47	58
	AC	6.3	0	115	115	-	-	-	-	-	-	-
Chopper Socket	DC	-	-	-	-	-	-	-	-	-	-	-
	AC	-	-	1.5 mV	-	-	-	-	-	-	-	-

Pin 10 to Pin 11 of J2	DC	11
	AC	0.32
Pin 10 to Pin 5 of J2	DC	5.4
	AC	15 mV

TABLE 2

TEST POINT RESISTANCES

Conditions:

Power turned off.
Tubes in sockets.
Amplifier and power supply interconnected (J2 to P2)
All measurements to chassis

Pin #	1	2	3	4	5	6	7	8	9	10	11
Tube											
V1 BEC 525001	1.2MΩ	6.8MΩ	11KΩ	16KΩ	16KΩ	500KΩ	2.2MΩ	6.8KΩ	16KΩ	-	-
V2 (6AU6)	850KΩ	3.8KΩ	16KΩ	16KΩ	500KΩ	1MΩ	3.8KΩ	-	-	-	-
V3 (7199)	68KΩ	300KΩ	1.1MΩ	0	0	1.2KΩ	1MΩ	20KΩ	1MΩ	-	-
V4 (6X4)	300Ω	-	0	0	-	300Ω	68KΩ	-	-	-	-
V5 (OA2)	50KΩ	0	-	0	50KΩ	-	0	-	-	-	-
J2 Socket	0	0	Inf.	Inf.	17KΩ	-	45KΩ	60KΩ	0	16KΩ	16KΩ

TABLE 3

CALIBRATION ADJUSTMENT PROCEDURE

Step	Reference Std. Voltage	Voltage Range Setting	Adjust #	Adjust To Read	Notes
1.	0.3 V	1	1	0.3 V	Main gain adjustment: affects down scale readings on ranges 3 V to .1V.
2.	0.9 V	1	2	0.9 V	Slope adjustment: affects up scale readings more than down scale: adjusts 1 V range only.
3.	2.5 V	3	3	2.5 V	Slope adjustment: affects up scale readings more than down scale: adjusts 3 V range only.
4.	0.25 V	.3	4	0.25 V	Slope adjustment: affects up scale readings more than down scale: adjusts .3 V range only.
5.	0.09 V	.1	5	0.09 V	Slope adjustment: affects up scale readings more than down scale: adjusts .1 V range only.
6.	0.003 V	.01	6	0.003 V	Main gain adjustment: affects down scale readings on ranges .03 V to .003 V.
7.	0.005 V	.01	7	0.005 V	Mid range slope adjustment: affects mid scale linearity on .01 V range only.
8.	0.009 V	.01	8	0.009 V	Slope adjustment: affects up scale readings more than down scale: adjusts .01 V range only.
9.	0.025 V	.03	9	0.025 V	Slope adjustment: affects up scale readings more than down scale: adjusts .03 V range only.
10.	0.0025 V	.003	10	0.0025 V	Slope adjustment: affects up scale readings more than down scale: adjusts .003V range only.
11.	0.0009 V	.001	11	0.0009 V	Main gain adjustment: adjusts calibration of .001V range only.

NOTE: Adjustment #1 to 6 are located from front to rear on right side of cabinet.
Adjustment #7 to 11 are located from rear to front on left side of cabinet.

SECTION VI

SHIPPING INSTRUCTIONS

6.1 If it becomes necessary to ship the instrument, the following steps should be followed:

a. Wrap the instrument with heavy wrapping paper and seal the seams with gummed tape. Place in fibreboard carton large enough to permit three inches of soft packing material between instrument and sides of box.

b. Separately wrap with heavy paper and pad the correct serial number probe and accessories and include with voltmeter.

c. Alternatively Boonton Electronics will provide an appropriate shipping container and packing materials at nominal cost. These may be obtained by writing to the Sales Department, Boonton Electronics Corporation, Route 287 at Smith Rd., Parsippany, N. J. 07054.

SECTION VII

REPLACEMENT PARTS LIST, MODEL 91CA

Circuit Reference	Description	BEC Part No.
C1	Capacitor, Mylar 0.1 µF 200V	230,116
C2	Capacitor, Mylar 0.1 µF 200V	230,116
C3	Capacitor, Mylar 0.1 µF 200V	230,116
C4	Capacitor, Mylar 0.1 µF 200V	230,116
C5	Capacitor, Mylar 0.0033 µF 200V	230,119
C6	Capacitor, Mylar 0.022 µF 200V	230,101
C7a,b	Capacitor, Elect. 20/50 µF 450/250V	283,139
C8	Capacitor, Mylar 0.005 µF 200V	230,121
C9	Capacitor, Elect. 50 µF 6V	283,145
C10	Capacitor, Elect. 50 µF 6V	283,145
C11	Capacitor, Mylar 0.1 µF 200V	230,116
C12	Capacitor, Mylar 0.022 µF 200V	230,101
C13	Capacitor, Mylar 0.1 µF 200V	230,116
C14	Capacitor, Mylar 0.1 µF 200V	230,116
C15	Capacitor, Mylar 0.047 µF±5% 200V	234,026
C16	Capacitor, Mylar 0.002 µF±5% 200V	234,024
C17	Capacitor, Elect. 50 µF 6V	283,145
C18	Capacitor, Mylar 0.033 µF±5% 200V	234,025
C19	Capacitor, Mylar 0.033 µF±5% 200V	234,025
C20	Capacitor, Mylar 0.022 µF 200V	230,101
C21	Capacitor, Mylar 0.1 µF 200V	230,116
C22	Capacitor, Mylar 0.1 µF 200V	230,116
C23	Capacitor, Met Paper 1.0 µF 200V	230,104
C24	Capacitor, Elect. 50 µF 6V	283,145
C25	Capacitor, Elect. 5 µF 50V	283,143
C27a,b,c	Capacitor, Elect. 20-20-20 µF 450V	283,113
C28a,b	Capacitor, Elect. 1000-1000 µF 15V	283,114
C29	Capacitor, Disc 0.05 µF 100V	224,117
C30	Capacitor, Elect. 50 µF 6V	283,145
C31	Capacitor, Mylar 0.1 µF 200V	230,116

Circuit Reference	Description	BEC Part No.
CH-1	Chopper, Special	540,113
CR-1	Rectifier, Sel. Sarkes-Tarzian #304B	532,001
D1	Diode 1N600	530,008
D2	Diode 1N600	530,008
D3	Diode Selected SG3113	530,040
D4	Diode Selected SG3113	530,040
F1	Fuse MDL 0.5 AMP	545,504
I1	Lamp #47	545,101
I2	Lamp #47	545,101
J1	Receptacle Amphenol 80-PC-2FT	479,119
J2	Socket Amphenol 77-MIP-11	472,101
L1	Choke Stancor #C1707 7H	440,001
M1	Meter Special 0-200 μA	554,139
P1	Plug Amphenol 80-MC-2MT	477,116
P2	Plug Amphenol 86-PM11-11	477,105
P3	Plug & AC Line Cord	568,101
	Adapter, Grounding for above	771,006
R1	Resistor, Comp. 330KΩ 1/2W 5%	301,147
R2	Resistor, Comp. 330KΩ 1/2W 5%	301,147
R3	Resistor, Dep. Car. 5.11MΩ 1/2W 1%	306,788
R4	Resistor, Dep. Car. 5.11MΩ 1/2W 1%	306,788
R5	Resistor, Dep. Car. 464KΩ 1/2W 1%	306,558

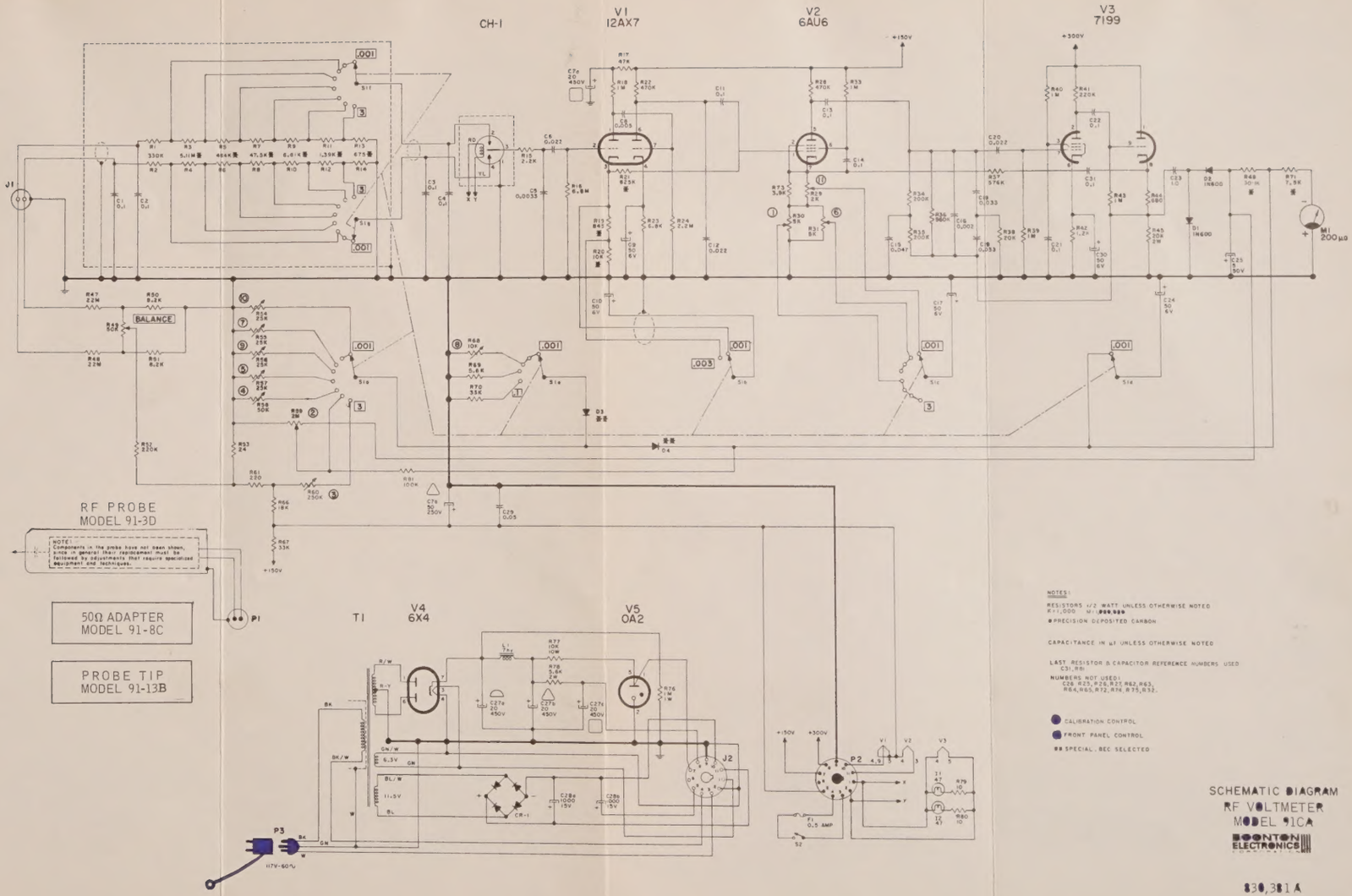
Circuit Reference	Description	BEC Part No.
R6	Resistor, Dep. Car. 464KΩ 1/2W 1%	306,558
R7	Resistor, Dep. Car. 47.5KΩ 1/2W 1%	306,440
R8	Resistor, Dep. Car. 47.5KΩ 1/2W 1%	306,440
R9	Resistor, Dep. Car. 6.81KΩ 1/2W 1%	306,339
R10	Resistor, Dep. Car. 6.81KΩ 1/2W 1%	306,339
R11	Resistor, Dep. Car. 1.39KΩ 1/2W 1%	306,694
R12	Resistor, Dep. Car. 1.39KΩ 1/2W 1%	306,694
R13	Resistor, Dep. Car. 675Ω 1/2W 1%	306,695
R14	Resistor, Dep. Car. 675Ω 1/2W 1%	306,695
R15	Resistor, Dep. Car. 2.2KΩ 1/2W 5%	301,095
R16	Resistor, Comp. 6.8MΩ 1/2W 5%	301,179
R17	Resistor, Comp. 47KΩ 1/2W 5%	301,127
R18	Resistor, Comp. 1MΩ 1/2W 5%	301,159
R19	Resistor, Dep. Car. 845Ω 1/2W 1%	306,231
R20	Resistor, Dep. Car. 10KΩ 1/2W 1%	306,359
R21	Resistor, Dep. Car. 825KΩ 1/2W 1%	306,589
R22	Resistor, Comp. 470KΩ 1/2W 5%	301,151
R23	Resistor, Comp. 6.8KΩ 1/2W 5%	301,107
R24	Resistor, Comp. 2.2MΩ 1/2W 5%	301,167
R28	Resistor, Comp. 470KΩ 1/2W 5%	301,151
R29	Resistor, Variable 2KΩ 2W 10% 11 ADJ.	311,126
R30	Resistor, Variable 5KΩ 2W 20% 1 ADJ.	311,101
R31	Resistor, Variable 5KΩ 2W 20% 6 ADJ.	311,101
R33	Resistor, Comp. 1 MΩ 1/2W 5%	301,159
R34	Resistor, Comp. 200KΩ 1/2W 5%	301,142
R35	Resistor, Comp. 200KΩ 1/2W 5%	301,142
R36	Resistor, Comp. 560KΩ 1/2W 5%	301,153

Circuit Reference	Description	BEC Part No.
R37	Resistor, Dep. Car. 576KΩ 1/2W 1%	306,570
R38	Resistor, Comp. 20KΩ 1/2W 5%	301,118
R39	Resistor, Comp. 1MΩ 1/2W 5%	301,159
R40	Resistor, Comp. 1MΩ 1/2W 5%	301,159
R41	Resistor, Comp. 220KΩ 1/2W 5%	301,143
R42	Resistor, Comp. 1.2KΩ 1/2W 5%	301,089
R43	Resistor, Comp. 1MΩ 1/2W 5%	301,159
R44	Resistor, Comp. 680Ω 1/2W 5%	301,083
R45	Resistor, Comp. 20KΩ 2W 5%	304,118
R46	Resistor, Dep. Car. 30.1KΩ 1/2W 1%	306,416
R47	Resistor, Comp. 22MΩ 1/2W 5%	301,191
R48	Resistor, Comp. 22MΩ 1/2W 5%	301,191
R49	Resistor, Variable 50KΩ 2W 20% BALANCE	311,125
R50	Resistor, Comp. 8.2KΩ 1/2W 5%	301,109
R51	Resistor, Comp. 8.2KΩ 1/2W 5%	301,109
R52	Resistor, Comp. 220KΩ 1/2W 5%	301,143
R53	Resistor, Comp. 24Ω 1/2W 5%	301,048
R54	Resistor, Variable 25KΩ 2W 20% 10 ADJ.	311,115
R55	Resistor, Variable 25KΩ 2W 20% 7 ADJ.	311,115
R56	Resistor, Variable 25KΩ 2W 20% 9 ADJ.	311,115
R57	Resistor, Variable 25KΩ 2W 20% 5 ADJ.	311,115
R58	Resistor, Variable 50KΩ 2W 20% 4 ADJ.	311,163
R59	Resistor, Variable 2MΩ 2W 20% 2 ADJ.	311,195
R60	Resistor, Variable 250KΩ 2W 20% 3 ADJ.	311,103
R61	Resistor, Comp. 220Ω 1/2W 5%	301,071
R66	Resistor, Comp. 18KΩ 1/2W 5%	301,117
R67	Resistor, Comp. 33KΩ 1/2W 5%	301,123
R68	Resistor, Variable 10KΩ 2W 20% 8 ADJ	311,102

Circuit Reference	Description	BEC Part No.
R69	Resistor, Comp. 5.6KΩ 1/2W 5%	301,105
R70	Resistor, Comp. 33K 1/2W 5%	301,123
R71	Resistor, Dep. Car. 7.5KΩ 1/2W 1%	306,344
R73	Resistor, Met. Film 3.9KΩ 1/2W 5%	315,002
R76	Resistor, Comp. 1MΩ 1W 20%	302,128
R77	Resistor, W.W. 10KΩ 10W 10%	312,103
R78	Resistor, Comp. 5.6KΩ 5%	304,105
R79	Resistor, Comp. 10Ω 1/2W 5%	301,039
R80	Resistor, Comp. 10Ω 1/2W 5%	301,039
R81	Resistor, Comp. 100KΩ 1/2W 5%	301,135
S1	Switch 7 pole 8 pos. Special	466,145
S2	Switch SPST. Carling #110-63	465,105
T1	Transformer Power, Special	446,016
V1	Elect. Tube 12AX7, Selected	525,001
V2	Elect. Tube 6AU6	526,6AU6
V3	Elect. Tube 7199	526,7199
V4	Elect. Tube 6X4	526,6X4
V5	Elect. Tube OA2	526,OA2

ACCESSORIES:

RF Probe	91-3D
50 Ω Adapter	91-8C
Probe Tip	91-13B



SCHEMATIC DIAGRAM
RF VOLTMETER
MODEL 91CA

BOONTON ELECTRONICS CORPORATION

830,381 A

Warranty

Boonton Electronics Corporation warrants its products to the original Purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to vacuum tubes that have given normal service, to sealed assemblies which have been opened, or to any item which has been repaired or altered without our authorization.

We will repair or, at our option, replace at no charge any of our products which are found to be defective under the terms of this warranty.

Model 91CA

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Model 91CA

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